

# Nucleon Spin Physics at RHIC

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The spin of the nucleon has its origin in quark and gluon polarizations and angular momenta. Deep-inelastic scattering experiments at SLAC, CERN, and DESY have measured the total of quark and anti-quark polarizations and found their contribution to the nucleon spin to be remarkably small (e.g. [1]). The gluon contribution is essentially unknown. The spin-program at RHIC proposes a series of complementary measurements with polarized proton-proton collisions that give direct sensitivity to gluon polarization and cover a wide kinematic range [2].

Our initial aim, while the collider strengthens its polarized proton capabilities, is to measure the double longitudinal spin asymmetry  $A_{LL}$  in inclusive jet production,

$$A_{LL} = \frac{\sigma^{++} - \sigma^{+-}}{\sigma^{++} + \sigma^{+-}} = \frac{1}{P_1 P_2} \left[ \frac{N^{++} - RN^{+-}}{N^{++} + RN^{+-}} \right]$$

where  $N_{++(+-)}$  are spin dependent yields for different spin orientations of the polarized beams with polarizations  $P_{1,2}$  and  $R$  is the relative luminosity for different proton spin orientations. The degree of polarization is measured by RHIC polarimeters, ultimately to an absolute uncertainty of 5%. Local polarimeters determine the polarization direction at the STAR interaction region (IR). The relative luminosity  $R$  is measured with Beam-Beam Counters (BBCs).

Jets are reconstructed with a midpoint-cone algorithm that clusters tracks measured with the STAR Time Projection Chamber (TPC) and energy deposits measured with the Barrel ElectroMagnetic Calorimeter (BEMC). For 2004 the BEMC was expanded to cover  $0 < \eta < 1$  for all azimuthal angles, about half of its final acceptance  $|\eta| < 1$ . The TPC covers the pseudorapidity range  $|\eta| < 1.6$  and  $2\pi$  in azimuth.

The data gathered during the polarized-proton machine development run in 2004 amount to about  $0.5 \text{ pb}^{-1}$  with measured average proton beam polarizations of about 35%. The reconstructed jet sample after selections consists of about 290 000 jets with transverse jet energies in the range of  $5 <$

$E_T^{\text{jet}} < 20 \text{ GeV}$ . About 200 000 of these events were triggered with the so-called high-tower trigger, which is defined by a BEMC tower reading above a transverse electromagnetic energy of about 2.5 GeV. The remaining events were triggered with the so-called jet-patch trigger, defined with groups of nearby towers. Detailed studies showed that the data, in particular those acquired with the jet-patch trigger, were contaminated with background characterized by electromagnetic energy deposits in a series of adjacent BEMC towers. The level of contamination was shown to strongly correlate with independent measures of background in the proton beams, such as those from the BBCs. The jet background, and its possible asymmetry, complicates the analysis of the 2004 data and has lead to the development of new tools to better characterize online the beam conditions at the STAR IR and to provide feedback to RHIC beam physicists for future data collection periods.

Preliminary evaluations of the asymmetry  $A_{LL}$  from the 2004 inclusive jet sample show consistency with next-to-leading order expectations based on deep-inelastic scattering data. The data collection period in 2005 is expected to yield a tenfold larger sample with improved beam polarizations. At this level of precision, the data will have the power to distinguish between several extreme gluon polarization models. Combined with proposed future high luminosity measurements of di-jet, prompt-photon, and heavy flavor production, the STAR measurement of inclusive jets will provide detailed insight into gluon polarization in the nucleon.

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